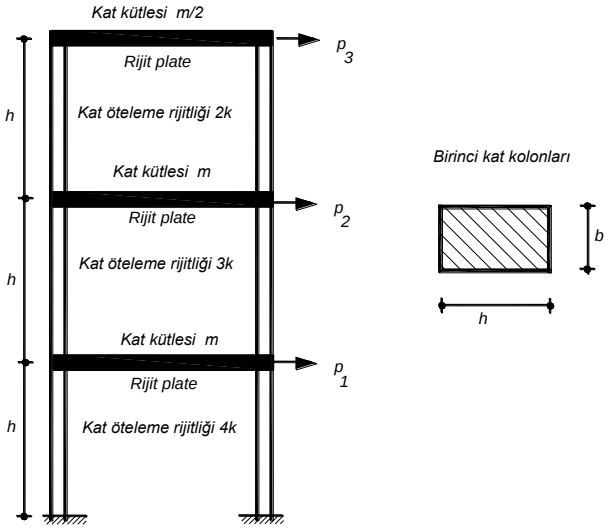
ADVANCED DYNAMICS OF STRUCTURES / Home Work 2 / October 15, 2007

Consider the system of three degrees-of-freedom shown:

a. Write down the equations of motion of the system by including the ground motion $v_g(t)$ and the external load $p_i(t)$ and evaluate the mass matrix **m** , the rigidity matrix **k,** and the flexibility matrix $\mathbf{k} = \mathbf{d}^{-1}$,
b. Determine the three circular frequencies and the periods of the free vibration ω_i and T_i and the corresponding mode shapes ϕ_i. Give their graphical representation ($i = 1, 2, 3$),
c. Check the orthogonality of the modes with respect to the mass matrix and the stiffness matrix $\phi_1^T \mathbf{m}\, \phi_2$, $\phi_1^T \mathbf{m}\, \phi_3$ and $\phi_1^T \mathbf{k}\, \phi_2$, $\phi_1^T \mathbf{k}\, \phi_3$,
d. Evaluate the generalized masses and stiffness $M_i = \phi_i^T \mathbf{m}\, \phi_i$, and $K_i = \phi_i^T \mathbf{k}\, \phi_i$, and assess $\omega_i^2 = K_i / M_i$.
e. Obtain the first free vibration mode shapes ϕ_1 and the corresponding the first circular frequencies ω_1 of the system by using Stodola method,
f. The heights of the stories are *h = 3 meter*, the columns of the first story have cross section of *0.30m×0.50m*, the first period of the system is $T_1 = 0.25s$ and $E = 30GPa$. Find the numerical values of the stiffness *k*, the mass *m*, the parameter *mg/k*, the second T_2 and the third T_3 period of the system.

ProfDr Hasan Boduroğlu
ProfDr Zekai Celep / http://www.ins.itu.edu.tr/zcelep/zc.htm



ADVANCED DYNAMICS OF STRUCTURES / Home Work 2/ October 15, 2007

Consider the system of three degrees-of-freedom shown:

a. Write down the equations of motion of the system by including the ground motion $v_g(t)$ and the external load $p_i(t)$ and evaluate the mass matrix **m** , the rigidity matrix **k,** and the flexibility matrix $\mathbf{k} = \mathbf{d}^{-1}$,
b. Determine the three circular frequencies and the periods of the free vibration ω_i and T_i and the corresponding mode shapes ϕ_i. Give their graphical representation ($i = 1, 2, 3$),
c. Check the orthogonality of the modes with respect to the mass matrix and the stiffness matrix $\phi_1^T \mathbf{m}\, \phi_2$, $\phi_1^T \mathbf{m}\, \phi_3$ and $\phi_1^T \mathbf{k}\, \phi_2$, $\phi_1^T \mathbf{k}\, \phi_3$,
d. Evaluate the generalized masses and stiffness $M_i = \phi_i^T \mathbf{m}\, \phi_i$, and $K_i = \phi_i^T \mathbf{k}\, \phi_i$, and assess $\omega_i^2 = K_i / M_i$
e. Obtain the first free vibration mode shapes ϕ_1 and the corresponding the first circular frequencies ω_1 of the system by using Stodola method,
f. The heights of the stories are *h = 3 meter*, the columns of the first story have cross section of *0.30m×0.50m*, the first period of the system is $T_1 = 0.25s$ and $E = 30GPa$. Find the numerical values of the stiffness *k*, the mass *m*, the parameter *mg/k*, the second T_2 and the third T_3 period of the system.

ProfDr Hasan Boduroğlu
ProfDr Zekai Celep / http://www.ins.itu.edu.tr/zcelep/zc.htm